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NATIONAL DAM INSPECTION PROGRAM. CHAMBERS DAM (NDI ID NUMBER PA--ETC(U)
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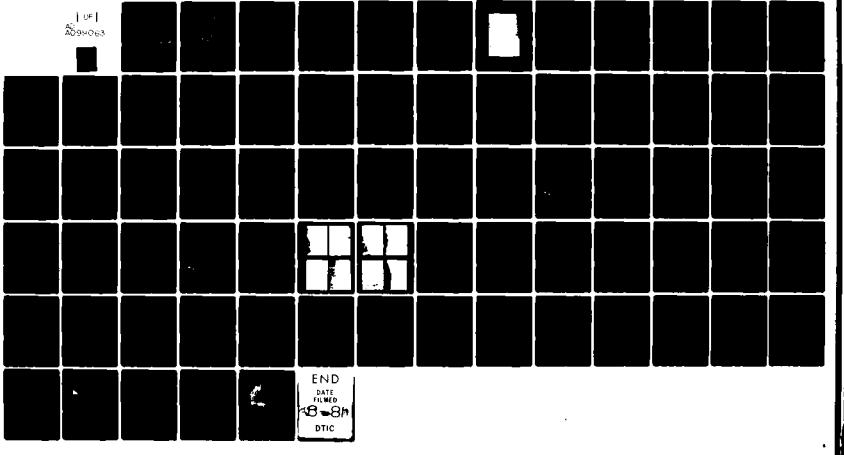

LEVEL II

OHIO RIVER BASIN
BANE CREEK, WASHINGTON COUNTY

PENNSYLVANIA

CHAMBERS DAM

NDI ID NO. PA-1093
DER ID NO. 63-21

CHAMBERS DAM ASSOCIATION

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Prepared By
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG, PENNSYLVANIA
15931

DAC W 31-81 C-0012

FOR
DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND
21203

APRIL, 1981

OHIO RIVER BASIN

BANE CREEK, WASHINGTON COUNTY

PENNSYLVANIA

(6) National Dam Inspection Program.

CHAMBERS DAM

(NDI ID Number PA-1093

DER ID Number 63-21)

CHAMBERS DAM ASSOCIATION

Ohio River Basin, Bane Creek, Washington County, Pennsylvania.

PHASE I INSPECTION REPORT.

NATIONAL DAM INSPECTION PROGRAM

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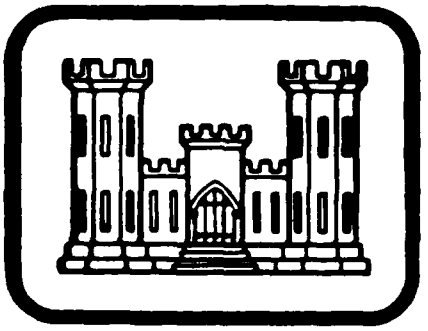

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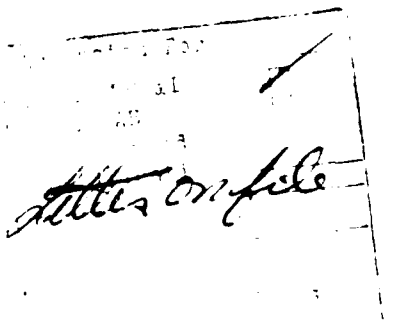
PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in detemining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.



PHASE I REPORT
NATIONAL DAM INSPECTION REPORT

NAME OF DAM	Chambers Dam
STATE LOCATED	Pennsylvania
COUNTY LOCATED	Washington
STREAM	Bane Creek
DATE OF INSPECTION	November 5, 1980
COORDINATES	Lat: 41° 5.2' Long: 80° 14.6'

ASSESSMENT

The assessment of Chambers Dam is based upon visual observations made at the time of inspection, review of available records and data, hydraulic and hydrologic computations and past operational performance.

The Chambers Dam appears to be in poor condition and poorly maintained. Erosion of the upstream slope has reduced the embankment crest to a width of 4 feet. Minor seepage was observed on the downstream slope of the dam, and a wet area was observed immediately beyond the toe of dam. Brush and trees litter the downstream slope of the dam. No determination could be made as to the actual condition of the drainline culvert through the embankment. No determination could be made as to the condition or type of upstream closure on the culvert or whether the control is operable. The spillway located at the right abutment of the dam is in a deteriorating condition. Erosion exists along the right outside edge of the spillway wingwall. If the erosion is left unchecked, the potential for failure of the spillway and dam exists.

The Chambers Dam is a high hazard-small size dam. The recommended Spillway Design Flood (SDF) for a dam of this size and classification is in the range of 1/2 PMF to PMF. Based on the downstream potential for loss of life and property damage, the spillway design flood has been selected as the PMF. The spillway and reservoir are capable of controlling less than 1% of the PMF without overtopping the embankment low spot. If the low spot elevation were filled to an elevation consistent with the remaining portion of the embankment crest, the spillway and reservoir would be capable of controlling approximately 15% of the PMF without overtopping the embankment. Based on criteria established by the Corps of Engineers, the spillway is termed seriously inadequate. The dam is classified as an unsafe, non-emergency structure.

The following recommendations and remedial measures should be instituted immediately.

1. A detailed hydraulic and hydrologic analysis should be conducted by a Registered Professional Engineer knowledgeable in dam design and construction to increase the spillway capacity.

2. The embankment crest is very irregular. The crest width of the dam should be widened to be consistent with the crest width in the area of the intake structure for the masonry culvert. Erosion protection measures should be taken to ensure against future erosion of the upstream slope. The work should be completed under the direction of a Registered Professional Engineer knowledgeable in dam design and construction.

3. The erosion located adjacent to the right spillway wingwall should be filled, and erosion protection measures should be taken to ensure that future erosion does not occur in the area. Erosion protection should also be provided along the left edge of the spillway adjacent to the embankment.

4. It should be ascertained whether the upstream control on the culvert is capable of operation. If the control is operable, it should be operated and lubricated on a regular basis. If the upstream control is not operable, it should be made operable or other provisions should be made for upstream closure of the culvert through the embankment.

5. An investigation should be made to determine the cause of the wet area beyond the toe and at the right abutment on the bench. A stability analysis should be conducted if the investigation of seepage indicates a concern for the stability of the dam due to seepage. Remedial measures should be made if the investigation indicates that such measures are necessary. Adequate drainage controls should be provided for the area.

6. The actual condition of the culvert should be investigated. Modifications or repairs to the culvert should be instituted as a result of the investigation.

7. The brush and trees should be cleared from the downstream slope under the direction of a Registered Professional Engineer knowledgeable in dam design and construction.

8. A regularly scheduled operations and maintenance program should be planned and implemented at the dam.

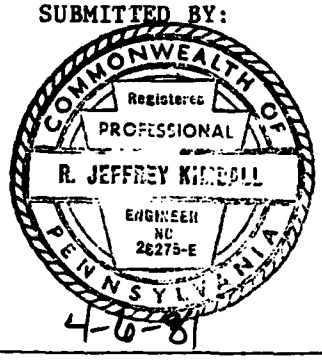
9. A warning system should be developed to warn downstream residents of large spillway discharges or imminent failure of the dam.

10. A safety inspection program should be implemented with inspections at regular intervals by qualified personnel.

CHAMBERS DAM
PA 1093

SUBMITTED BY:

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS



4-6-81

Date

R. Jeffrey Kimball

R. Jeffrey Kimball, P.E.

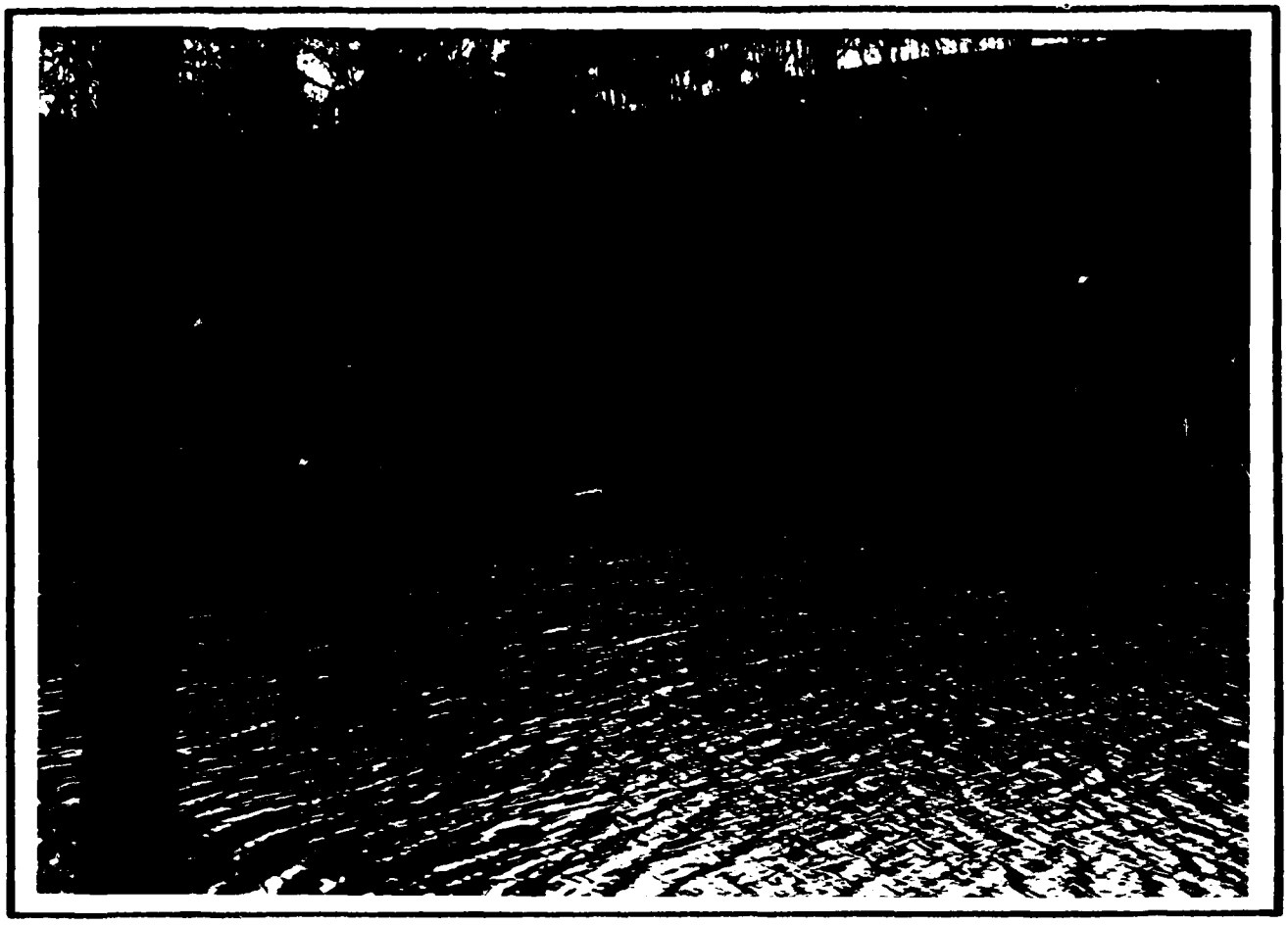
APPROVED BY:

21 APR 81

Date

James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer



Overview of Chambers Dam.

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PHASE I
NATIONAL DAM INSPECTION PROGRAM

CHAMBERS DAM
NDI. I.D. NO. PA 1093
DER I.D. NO. 63-21

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. The Chambers Dam is an earthfill dam with a stone wall at the downstream toe, 260 feet long and 17 feet high. The crest width of the dam varies, with the majority of the crest being approximately 4 feet in width. The upstream slope of the dam is approximately 1H:1V, and the downstream slope of the dam is 1.75H:1V with a bench at the toe of the slope. A dry masonry wall exists beyond the bench. The wall is vertical and exists along the entire length of the downstream toe of the dam.

A concrete structure exists on the upstream slope of the dam near the left abutment. The structure houses a gate which controls flow through a rectangular culvert through the dam. The control facilities and the culvert were part of a raceway facility utilized to power a grist mill downstream of the dam. The raceway and grist mill have since been abandoned.

The spillway for the dam is located at the right abutment. The spillway is rectangular with concrete retaining walls and a solid concrete pier near the center of the spillway. A foot bridge exists across the spillway crest. A concrete lined channel serves to provide discharges to the stream below the spillway. The effective weir length associated with the spillway control section is 21.5 feet.

b. Location. The dam is located on Bane Creek, approximately 2 miles North of the Village of Banetown, South Franklin Township, Washington County, Pennsylvania. The Chambers Dam can be located on the Amity, U.S.G.S. 7.5 minute quadrangle.

c. Size Classification. The Chambers Dam is a small size dam (17 feet high, 55 acre-feet).

d. Hazard Classification. The Chambers Dam is a high hazard dam. Downstream conditions indicate that the loss of more than a few lives and property damage is probable should the structure fail. The Village of Banetown is located approximately 2 miles downstream of the dam.

e. Ownership. The Chambers Dam is owned by The Chambers Dam Association. Correspondence should be addressed to:

The Chambers Dam Association
c/o Mr. M.H. Rupert, President
P.O. Box 409
Washington, Pennsylvania 15301
412/222-1140

f. Purpose of Dam. The dam was originally constructed for the purposes of supplying water for the operations associated with a grist mill located downstream of the dam. The grist mill has since been abandoned and the dam is presently utilized for the purposes of recreation for the members of the Chambers Dam Association.

g. Design and Construction History. Based on information contained in the PennDER, files it appears as though the dam was originally constructed sometime around 1820. No information was available relative to the original design and construction of the dam.

Around 1919, inspections of the structure by the Water Supply Commission of Pennsylvania (Dam Division) were made with subsequent orders to repair the structure. The owner of the dam at that time was Mrs. Sara Dodd. The 1920 repairs ordered by the Commission were completed by the McVehil Contracting Company, 46 East Wheeling Street, Washington, Pennsylvania. It appears as though the work was completed sometime around 1924.

h. Normal Operating Procedures. The reservoir is currently maintained at the spillway crest elevation. No operations have been conducted at the dam for many years. No date is associated with the abandonment of the Chambers Grist Mill.

1.3 Pertinent Data.

a. Drainage Area. 1.49 square miles

b. Discharge at Dam Site (cfs).

Maximum flood at dam site	Unknown
Drainline capacity at normal pool	Unknown
Spillway capacity at top of dam (low spot)	25
Spillway capacity at top of sidewalls	355

c. Elevation (U.S.G.S. Datum) (feet). - Field survey based on a spillway crest elevation, 1102.0 feet U.S.G.S. 7.5 minute quadrangle.

Top of dam - low point	1102.5
Top of dam - design height	Unknown
Pool at time of inspection	1102.0
Spillway crest	1102.0
Maximum pool - design surcharge	Unknown
Normal pool	1102.0
Upstream portal - culvert	Unknown
Downstream portal - culvert (approximately)	1090.0
Maximum tailwater	Unknown
Toe of dam	1085.5

d. Reservoir (feet).

Length of maximum pool	2400
Length of normal pool	1600

e. Storage (acre-feet).

Normal pool (spillway crest)	50
Top of dam - low spot	55

f. Reservoir Surface (acres).

Top of dam - low spot	10
Normal pool	9
Spillway crest	9

g. Dam.

Type	Earthfill with a stone wall along the downstream toe
Length (including spillway)	260
Height	17 feet
Top width	4 feet to 8 feet
Side slopes - upstream	1H:1V
- downstream	1.75H:1V to elevation 1096.5. Vertical below elevation 1096.5
Zoning	Unknown
Impervious core	Unknown
Cutoff	Unknown
Grout curtain	Unknown

h. Reservoir Drain.

Type	Dry Masonry culvert through embankment
Length (approximately)	30 feet
Closure	Unknown
Access	Upstream slope
Regulating facilities	Housed in concrete structure on upstream slope of dam

i. Spillway.

Type	Rectangular
Length (effective crest length)	21.5 feet
Crest elevation	1102.0
Upstream channel	Lake (unrestricted)
Downstream channel	Bane Creek

SECTION 2
ENGINEERING DATA

2.1 Design. No information was available relative to the design of the structure. Information contained in the DER files suggests that the dam was constructed sometime around 1820.

2.2 Construction. No information is available regarding the construction of the dam.

2.3 Operation. No operations are conducted at the dam at this time.

2.4 Evaluation.

a. Availability. No engineering information was available for review relative to the structure. Mr. John O'Brian, a professional engineer and a member of the Chambers Dam Association, accompanied the inspection team during the inspection of the dam. Mr. O'Brian was interviewed to obtain information relative to the past operation and maintenance of the dam. Mr. O'Brian was unable to supply any information regarding the original design of the structure.

b. Adequacy. This Phase I Report is based on the visual inspection and hydrologic and hydraulic analysis. Sufficient information exists to complete a Phase I Report.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The onsite inspection of the Chambers Dam was conducted by personnel of L. Robert Kimball and Associates on November 5, 1980. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portion of any outlet works and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.
4. Evaluation of the downstream area hazard potential.

b. Dam. The dam appeared to be in poor condition and poorly maintained. From a brief survey conducted during the inspection, it was noted that the low spot on the top of dam exists adjacent to the right spillway wingwall at the right abutment of the dam. Erosion adjacent to the outside edge of the right spillway wingwall has apparently occurred for sometime. It was noted during the inspection that continual erosion in the area could lead to possible failure of the spillway and dam.

Considerable erosion has occurred on the upstream slope of the dam. The erosion has apparently been unchecked for many years, as evidenced by the reduced width of the crest between the entrance to the drainline culvert and the spillway at the right abutment. The upstream slope of the dam is approximately 1H:1V. The downstream slope of the dam is 1.75H:1V, and a bench exists at the toe of the downstream slope. A dry masonry retaining wall is located below the bench. The crest of the dam is grass covered, as is the downstream slope and bench area. Small trees and brush exist on the downstream slope of the dam and along the bench above the masonry retaining wall.

A broad area of seepage area was observed on the downstream slope of the dam at the junction of the embankment and the spillway. The area was visibly wet and no estimate of the quantity of the seepage could be made.

The dry masonry retaining wall located along the downstream face of the embankment appeared to be in good condition. The exit invert of the approximately 3' x 3' culvert was inspected. No determination could be made as to the actual condition of the culvert. A large area immediately downstream of the masonry wall was extremely saturated.

c. Appurtenant Structures. The spillway was in a deteriorated condition. Erosion was occurring beyond the right spillway wingwall. A concrete bridge pier located near the center of the spillway showed visible signs of deterioration at the base of the pier. A footbridge spans the spillway crest.

The structure on the upstream slope of the dam which houses the control for the drainline culvert has apparently deteriorated over the years. No visible mechanism was observed to regulate the control device. The type of device controlling entrance to the culvert was not visible, and no determination could be made as to the type of device utilized to control the entrance to the culvert. Mr. John O'Brian, a professional engineer and a member of the Chambers Dam Association, accompanied the inspection team and could not supply any information relative to the last time the culvert controls have been operated.

d. Reservoir Area. The watershed for the Chambers Dam is covered almost equally with forested areas and farmland. The reservoir slopes are moderate to steep but do not appear to be susceptible to landslides which would affect the storage volume of the reservoir or overtopping of the dam by displacing water.

e. Downstream Channel. The downstream channel for the Chambers Dam consists of Bane Creek. The Village of Banetown is located approximately 2 miles downstream of the dam. Two trailers are located approximately 1 mile downstream of the dam. The population of the two trailers is estimated at 8 people.

3.2 Evaluation. In general, the dam and appurtenant structures appear to be in poor condition and poorly maintained.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures. No operational procedures are conducted at the dam. Normal inflow to the reservoir is discharged through the spillway located at the right abutment of the dam.

4.2 Maintenance of the Dam. No planned maintenance schedule exists for the dam. The dam is in a deteriorating condition. Erosion of the upstream slope of the dam and the growth of vegetation on the downstream slope of the dam has remained unchecked.

4.3 Maintenance of Operating Facilities. There is no maintenance of the operating facilities. No known date is associated with the last operation of the controls at the inlet of the 3' x 3' masonry culvert through the dam. The spillway is in a deteriorating condition, and erosion exists around the right spillway wingwall. No planned maintenance schedule exists for the operating facilities at the dam.

4.4 Warning System in Effect. There is no warning system in effect to warn downstream residents of large spillway discharges or imminent failure of the dam.

4.5 Evaluation. Maintenance of the dam and operating facilities is considered poor.

An emergency action plan should be available for every dam in the high and significant hazard category. Such plans should outline actions to be taken by the operator to minimize downstream effects of an emergency and should include an effective warning system. No emergency action plan has been developed and the owner should develop such an action plan.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. No design data was available relative to the hydraulic and hydrologic controls associated with the structure.

b. Experience Data. No rainfall, runoff or reservoir level data were available. The spillway reportedly has functioned adequately in the past.

c. Visual Observations. The spillway appeared to be in a deteriorating condition. No major deficiencies were observed which would affect the discharge potential of the spillway.

The low spot on the embankment crest was observed to exist adjacent to the right spillway wingwall at the right abutment of the dam.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California, July, 1978. The major methodologies or key input data for this program are discussed briefly in Appendix D.

5.2 Evaluation Assumptions. To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions.

1. The pool elevation in the reservoir prior to the storm was assumed to be at the spillway crest elevation, 1102.0.

2. The top of dam was considered to be the low spot elevation, 1102.5.

3. The spillway crest is assumed to be at a constant elevation along its entire length.

4. Three smaller upstream dams were not considered in the analysis.

5.3 Summary of Overtopping Analysis. Complete summary sheets for the computer output are presented in Appendix D.

Peak inflow (PMF)	4800 cfs
Spillway capacity - low spot	25 cfs
Spillway capacity - top of spillway wall	355 cfs

a. Spillway Adequacy Rating. The Spillway Design Flood (SDF) is based on the hazard and size classification of the dam. The recommended spillway design flood for a dam of this size and classification is in the range of 1/2 PMF to the PMF. Based on the potential loss of life and property damage, the spillway design flood has been selected as the PMF. Based on the following definition provided by the Corps of Engineers, the spillway is rated as seriously inadequate as a result of our hydrologic analysis.

> Seriously inadequate - All high hazard dams not capable of passing at least 50% of the PMF and where there is a significant increase in the downstream potential for loss of life due to dam failure from that which existed just prior to the failure.

The spillway and reservoir are capable of controlling less than 1% of the PMF without overtopping the embankment low spot. If the low spot area were filled to an elevation consistent with the remaining portion of the crest (elevation 1104.5), the spillway and reservoir would be capable of controlling approximately 15% of the PMF without overtopping the embankment.

5.4 Summary of Dam Breach Analysis. As the analysis indicates the subject dam cannot satisfactorily pass 50% of the PMF, it was necessary to perform the dam breach analysis and downstream routing of the flood wave. This analysis determines the degree of increased flooding due to dam failure. A pool elevation of 1104.6 (2.1 feet of overtopping) was considered sufficient to cause failure of the dam due to overtopping.

The results of the dam breach analysis indicate that the downstream potential for loss of life and property damage is significantly increased by dam failure due to the momentum associated with the flood wave. The trailers could be swept away by the flood wave. Therefore, the spillway is rated as seriously inadequate. The Chambers Dam is classified as an unsafe, non-emergency structure. Details of the downstream routing of the flood wave are included in Appendix D.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. No visible deficiencies were observed on the embankment which were considered as requiring immediate action. Erosion of the upstream slope was evident and had been apparently left unchecked for a number of years. A small seepage area was observed on the downstream slope adjacent to the left spillway wingwall. The seepage area was visibly saturated but no concentrated seepage areas were observed. No determinations could be made as to the quantity of seepage. The downstream slope of the structure contains numerous small trees and brush and the brush and trees should be cleared from the slope. No determination could be made as to the actual condition of the culvert which exists through the embankment.

The spillway was in a visibly deteriorated condition. A concrete bridge pier near the center of the spillway showed visible deterioration. Erosion around the right spillway wingwall was evident and continued erosion in the area could lead to potential failure of the spillway structure. The dry masonry wall appeared to be in good condition.

b. Design and Construction Data. No design and construction data were available relative to the original design of the dam.

c. Operating Records. No operating records exist for the dam.

d. Post Construction Changes. Based on information contained in the DER correspondence file, it appears as though significant modifications were made to the dam around 1920. The work was completed by the McVehil Contracting Company, 46 East Wheeling Street, Washington, Pennsylvania. A 1920 report contained in the DER files indicates that the crest line of the dam had been approved and that previous erosion had been repaired. Riprap was apparently placed along the upstream face of the dam and along the spillway approach adjacent to the left edge of the spillway. Also, additional riprap was placed along the spillway approach. The irregularities in the top of dam had been filled to conform with requirements of the Water Supply Commission. Additional information in the correspondence file indicates that the left section of the spillway was rebuilt in 1945.

The dam has a long history of seepage along the right abutment in the spillway area and in the area of the 3' x 3' masonry culvert. There are occassional references in the DER correspondence file indicating that the seepage through the culvert should be investigated, but no information was located in the files in regards to an analysis.

e. Seismic Stability. The dam is located in seismic zone 1. No seismic stability analyses has been performed. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake loading. Since no signs of instability were noted during the inspection, the Chambers Dam is assumed to be safe for earthquake loading.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The dam appears to be in poor condition and poorly maintained. Extensive erosion exists along the upstream slope of the dam, and the crest width has been reduced to approximately 4 feet. Past information indicates that the crest width at one time had been as much as 8 feet. A small seepage area was observed on the downstream slope adjacent to the left spillway wingwall. Brush and small trees exist along the downstream slope of the dam.

The inspection of the dry masonry retaining wall along the downstream toe of the dam did not disclose any significant deterioration of the wall. A saturated area exists immediately beyond the downstream toe of the wall. No concentrated seepage areas were noted during the inspection, and no determination could be made as to the actual quantity of seepage through the embankment.

The spillway is in a visibly deteriorating condition. Erosion exists along the right spillway wingwall. Continued erosion in the area could lead to the potential failure of the spillway and dam.

No determination could be made as to the actual condition of the culvert which exists through the dam. A history of seepage exists at the dam and past reports indicate that seepage existed through the culvert.

The visual observations, review of available data, hydraulic and hydrologic calculations and past operational performance indicate that the Chambers Dam is capable of controlling less than 1% of the PMF. If the low spot on the embankment crest adjacent to the right spillway wingwall were filled to an elevation consistent with the remaining portion of the crest (elevation 1104.5), the spillway and reservoir would be capable of controlling approximately 15% of the PMF. The spillway is termed seriously inadequate. The dam is classified as an unsafe, non-emergency structure.

b. Adequacy of Information. Sufficient information is available to complete a Phase I report.

c. Urgency. The recommendations suggested below should be implemented immediately.

d. Necessity for Further Investigation. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 Recommendations/Remedial Measures.

1. A detailed hydraulic and hydrologic analysis should be conducted by a Registered Professional Engineer knowledgeable in dam design and construction to increase the spillway capacity.

2. The embankment crest is very irregular. The crest width of the dam should be widened to be consistent with the crest width in the area of the intake structure for the masonry culvert. Erosion protection measures should be taken to ensure against future erosion of the upstream slope. The work should be completed under the direction of a Registered Professional Engineer knowledgeable in dam design and construction.

3. The erosion located adjacent to the right spillway wingwall should be filled, and erosion protection measures should be taken to ensure that future erosion does not occur in the area. Erosion protection should also be provided along the left edge of the spillway adjacent to the embankment.

4. It should be ascertained whether the upstream control on the culvert is capable of operation. If the control is operable, it should be operated and lubricated on a regular basis. If the upstream control is not operable, it should be made operable or other provisions should be made for upstream closure of the culvert through the embankment.

5. An investigation should be made to determine the cause of the wet area beyond the toe and at the right abutment on the bench. A stability analysis should be conducted if the investigation of seepage indicates a concern for the stability of the dam due to seepage. Remedial measures should be made if the investigation indicates that such measures are necessary. Adequate drainage controls should be provided for the area.

6. The actual condition of the culvert should be investigated. Modifications or repairs to the culvert should be instituted as a result of the investigation.

7. The brush and trees should be cleared from the downstream slope under the direction of a Registered Professional Engineer knowledgeable in dam design and construction.

8. A regularly scheduled operations and maintenance program should be planned and implemented at the dam.

9. A warning system should be developed to warn downstream residents of large spillway discharges or imminent failure of the dam.

10. A safety inspection program should be implemented with inspections at regular intervals by qualified personnel.

APPENDIX A
CHECKLIST, VISUAL INSPECTION, PHASE I

CHECK LIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Chambers Dam COUNTY Washington STATE Pennsylvania ID# 1093

TYPE OF DAM Earthfill HAZARD CATEGORY High

DATE(s) INSPECTION November 5, 1980 WEATHER Clear and cool . TEMPERATURE 30°

POOL ELEVATION AT TIME OF INSPECTION 1102.0 M.S.L. TAILWATER AT TIME OF INSPECTION None M.S.L.

INSPECTION PERSONNEL:

R. Jeffrey Kimball, P.E. - L. Robert Kimball and Associates

James T. Hockensmith - L. Robert Kimball and Associates

O.T. McConnell - L. Robert Kimball and Associates

Mr. John O'Brian, P.E. - Member of the Chambers Dam Association

O.T. McConnell
RECORDER

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None noted.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None noted.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Considerable erosion exists along the upstream slope of the dam and in the area of the spillway.	Erosion areas should be repaired and erosion protection measures taken.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Appears to be all right.	
RIPRAP FAILURES	Riprap once existed on the entire length of the upstream slope. Apparently erosion has destroyed the protection and considerable erosion exists on the upstream slope and in the spillway area.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	Brush and small trees exist on the downstream slope of the dam.	The brush and trees should be removed.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Considerable erosion exists in the area of the spillway and dam. The low spot on the dam crest exists adjacent to the right spillway wingwall.	The erosion should be repaired.
ANY NOTICEABLE SEEPAGE	Seepage observed along the left spillway wingwall on the downstream of the embankment slope. No concentrated seepage was observed therefore, no quantity of seepage could be determined.	
STAFF GAUGE AND RECORDER	None.	
DRAINS	None.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Not applicable.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Not applicable.	
DRAINS	Not applicable.	
WATER PASSAGES	Not applicable.	
FOUNDATION	Not applicable.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Not applicable.	
STRUCTURAL CRACKING	Not applicable.	
VERTICAL AND HORIZONTAL ALIGNMENT	Not applicable.	
MONOLITH JOINTS	Not applicable.	
CONSTRUCTION JOINTS	Not applicable.	
STAFF GAUGE OR RECORDER	Not applicable.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None observed.	
INTAKE STRUCTURE	Control structure exists on the upstream slope of the dam. The control for the structure was not visible and no information exists relative to the facility.	The control facility should be investigated to determine whether or not it is operable.
OUTLET STRUCTURE	Outlet structure for the culvert exists in the downstream wall of the dam. No determination could be made as to the condition of the culvert.	
OUTLET CHANNEL	Banes Creek [unobstructed].	
EMERGENCY GATE	Control facilities exist on the upstream slope of the dam. No determination could be made as to the type of control facility.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete appears to be in fair condition. A concrete bridge pier exists near the center of the spillway crest and is in a deteriorating condition.	The concrete in the spillway area should be repaired.
APPROACH CHANNEL	Unobstructed lake.	
DISCHARGE CHANNEL	Bane Creek. Channel appears to be sufficient to discharge flows from the spillway.	
BRIDGE AND PIERS	A foot bridge spans the spillway crest. A concrete pier exists approximately halfway across the crest.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable.	
APPROACH CHANNEL	Not applicable.	
DISCHARGE CHANNEL	Not applicable.	
BRIDGE AND PIERS	Not applicable.	
GATES AND OPERATION EQUIPMENT	Not applicable.	

DOWNSTREAM CHANNEL

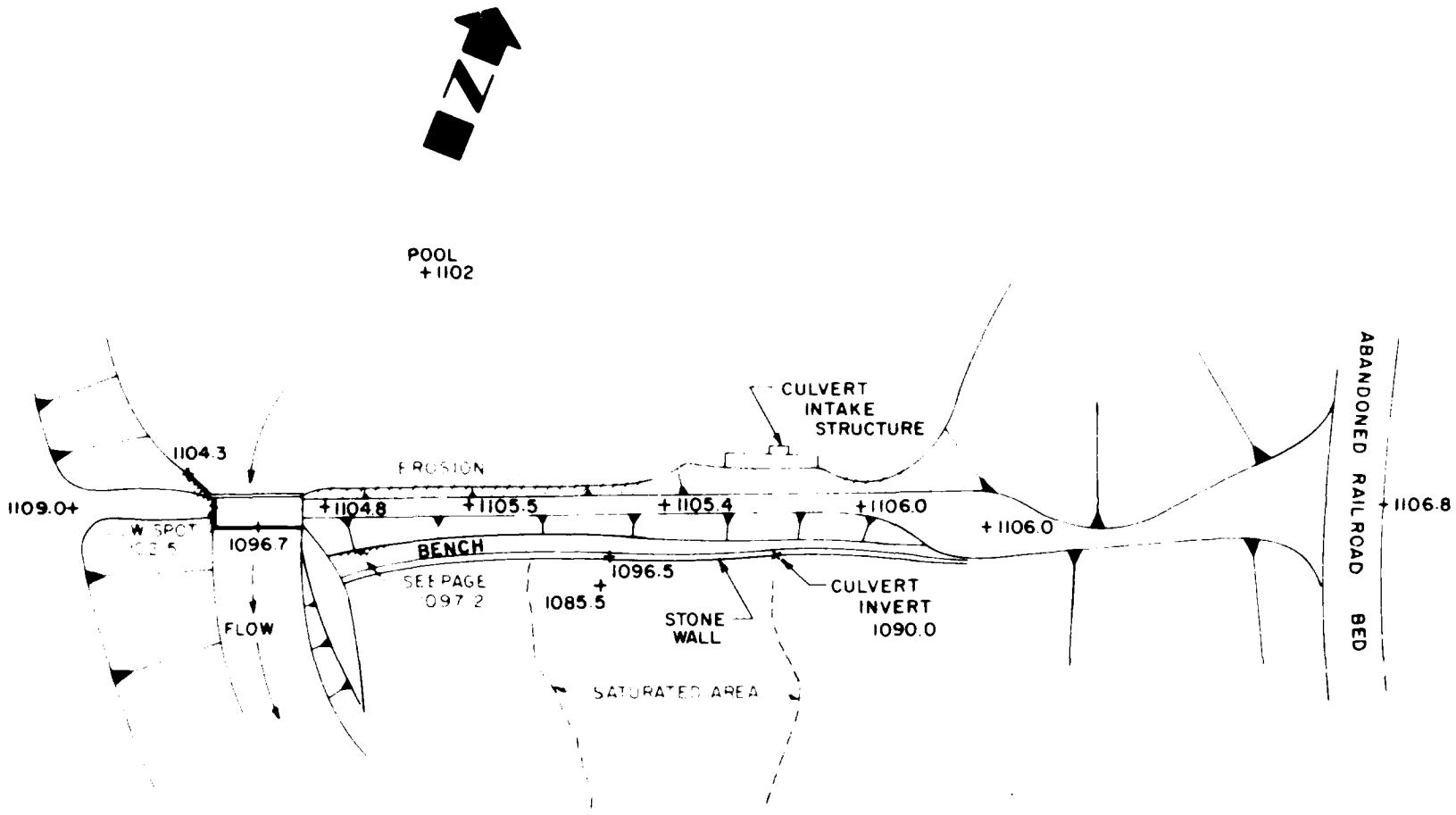
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The discharge channel for Chambers Dam consists of Bane Creek. Two trailers are located along the downstream channel approximately 6,000 feet below the dam. The channel is unobstructed.	A warning system should be provided.
SLOPES	Appear to be stable.	
APPROXIMATE NO. OF HOMES AND POPULATION	The Village of Banetown is located approximately 2 miles downstream of the dam. Two trailors exist along the downstream channel approximately 6,000 feet below the dam. The population is estimated at 8 people.	

RESERVOIR

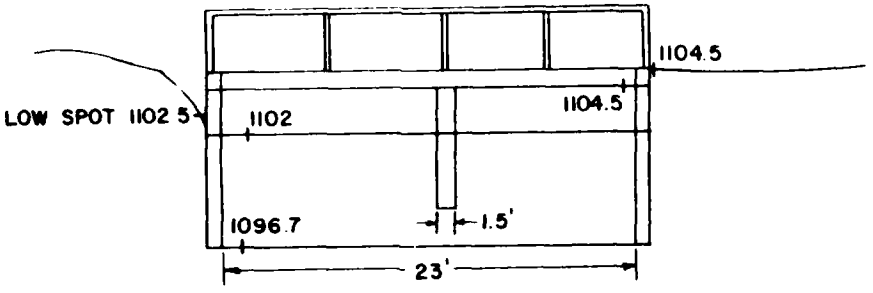
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderate to steep, but appear to be stable.	
SEDIMENTATION	Unknown.	

INSTRUMENTATION

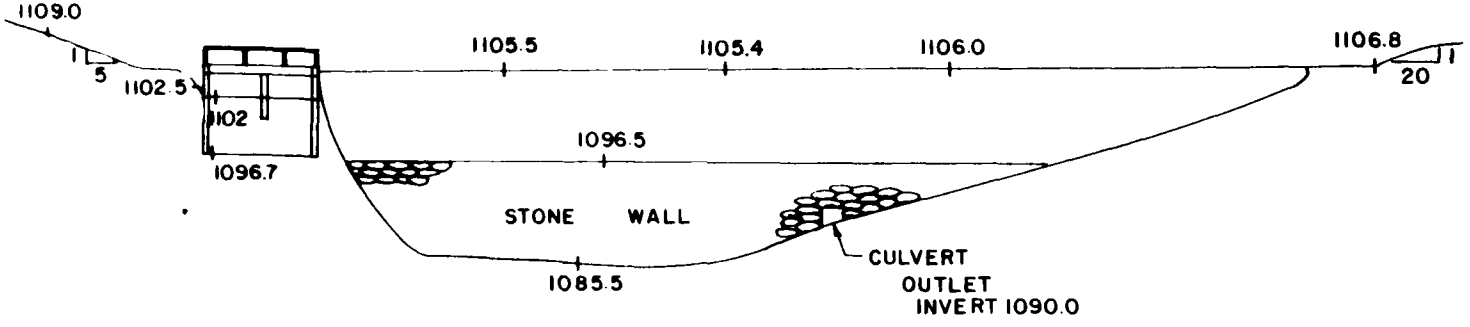
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	



CHAMBERS DAM
SCALE: 1" = 40'



SPILLWAY PROFILE
LOOKING UPSTREAM
SCALE: 1"=10'



PROFILE
LOOKING UPSTREAM

SCALE: HORIZ. 1"= 40'
VERT. 1"= 20'

CHAMBERS DAM

A-13

APPENDIX B

CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION, OPERATION, PHASE I

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Chambers Dam

ID# PA 1093

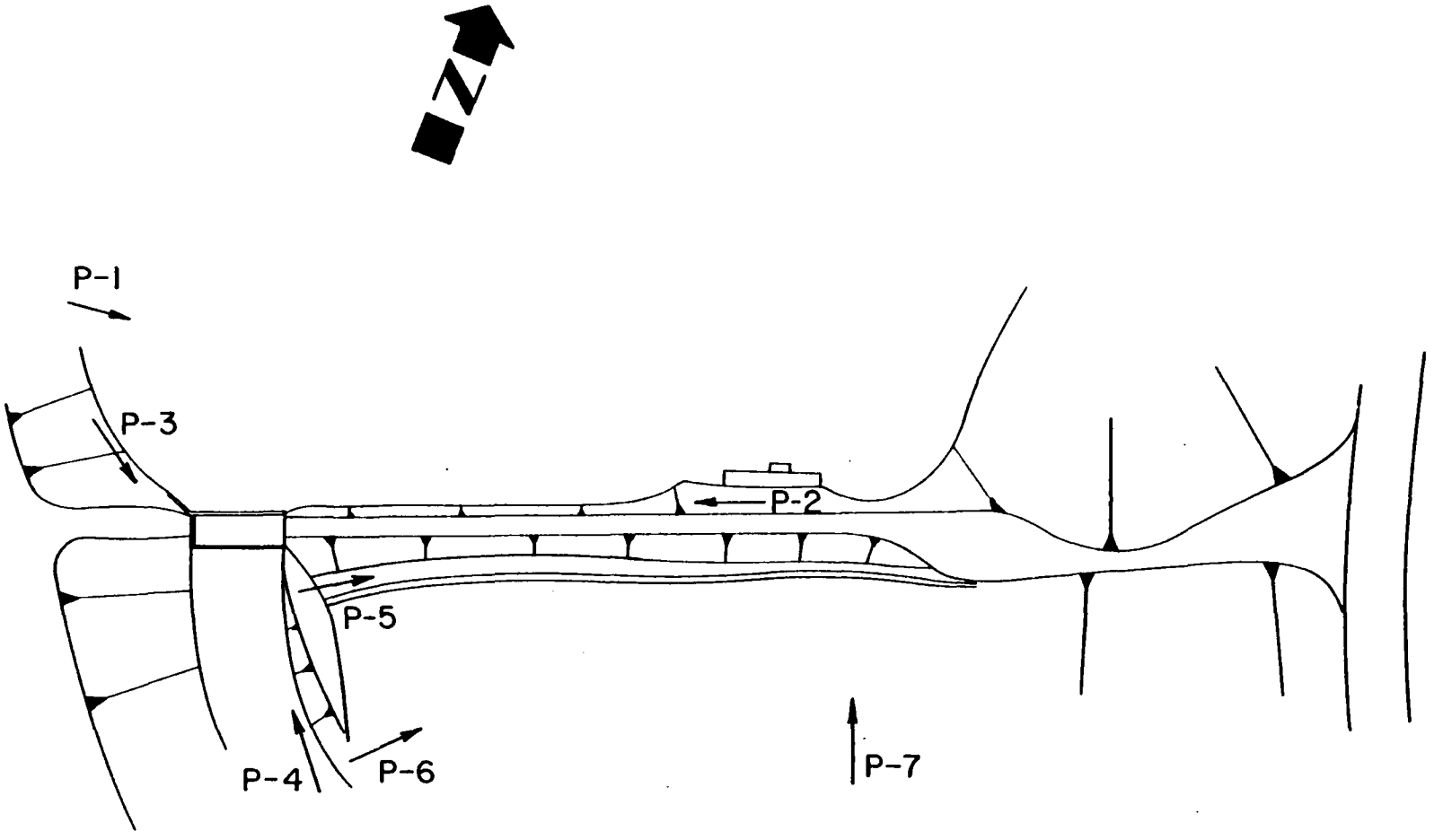
ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	U.S.G.S quadrangle.
CONSTRUCTION HISTORY	None.
TYPICAL SECTIONS OF DAM	None.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS RAINFALL/RESERVOIR RECORDS	None. None. None. None. None.

ITEM	REMARKS
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None.
POST-CONSTRUCTION SURVEYS OF DAM	Unknown.
BORROW SOURCES	Unknown.

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	Modifications made to the dam in 1920. Crest of dam was widened and riprap protection provided. Other details available in DER files.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None known to exist.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None known to exist.
MAINTENANCE OPERATION RECORDS	None.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	Limited information obtained in Appendix D.
OPERATING EQUIPMENT PLANS & DETAILS	None.

APPENDIX C
PHOTOGRAPHS



P-INDICATES PHOTO LOCATION

CHAMBERS DAM
PHOTO INDEX

CHAMBERS DAM
PA 1093

Sheet 1

Front

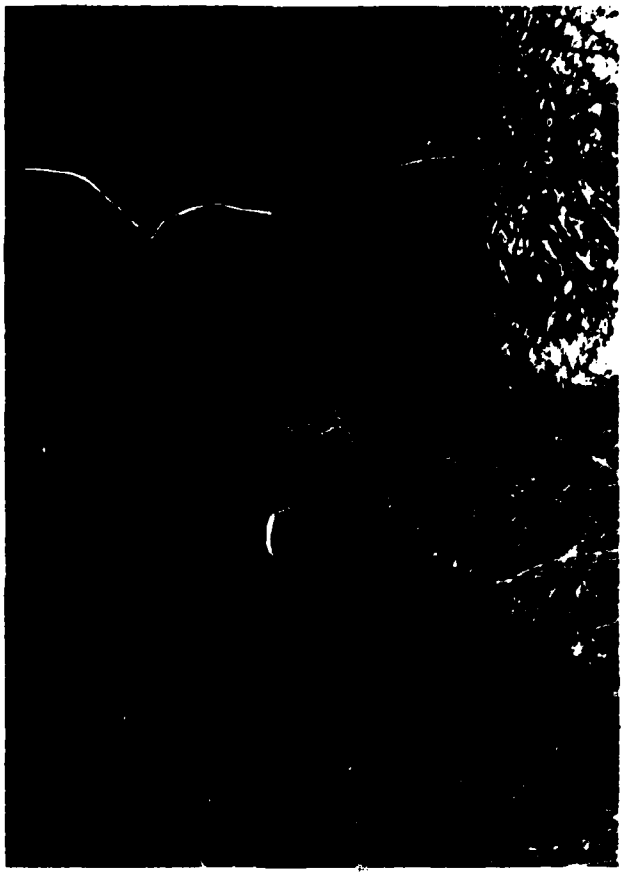
(1) Upper left - View of upstream slope, abandoned drainline intake and left abutment.
(2) Upper right - View of embankment crest, spillway approach and the right abutment. Note the excessive erosion on the upstream slope of the embankment.
(3) Lower left - View of right spillway wingwall. Note the erosion around the approach wingwall. The erosion continues along the outside edge of the discharge wingwall.
(4) Lower right - View of the spillway crest and downstream face of the discharge structure. Note the foot bridge which spans the spillway crest and the deterioration of the concrete wingwalls and the mid-span supporting structure.

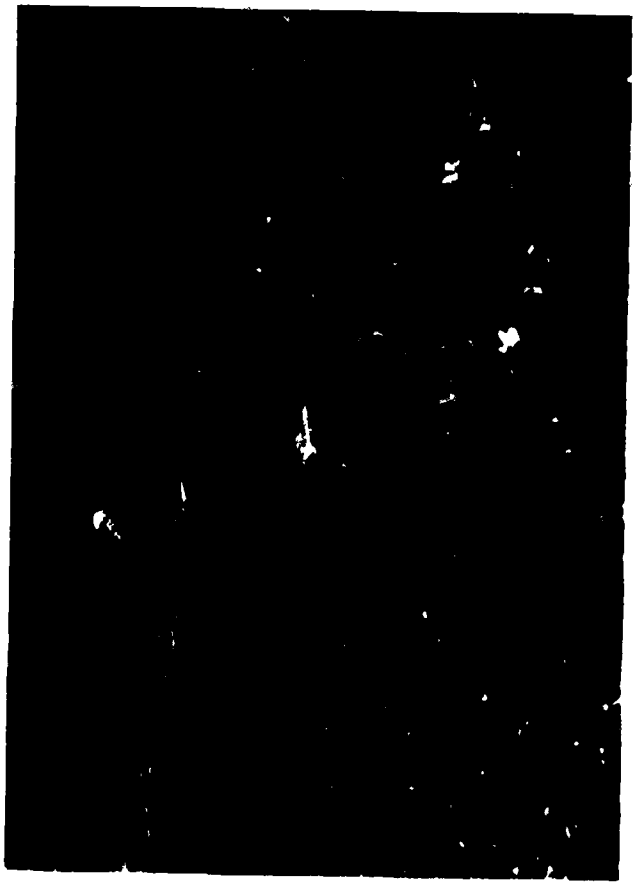
Back

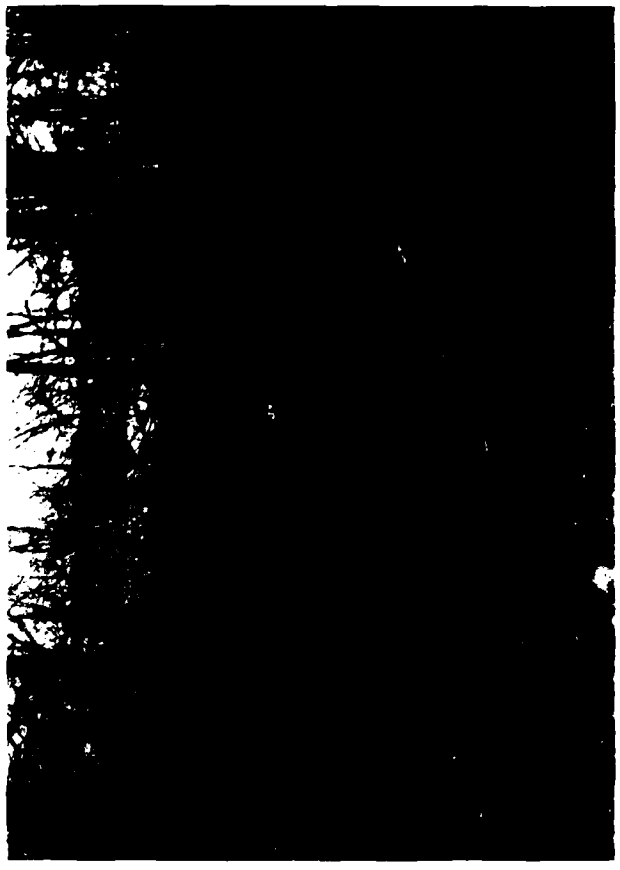
(5) Upper left - Overview of embankment crest, bench area and the vertical stonewall along the downstream face of the embankment section.
(6) Upper right - View of the vertical downstream face of the embankment. The area immediately beyond the downstream toe of the wall is saturated, although no ponded water was observed during the inspection.
(7) Lower left - View of the downstream face at the outlet for the abandoned culvert drain.
(8) Lower right - Downstream exposure.

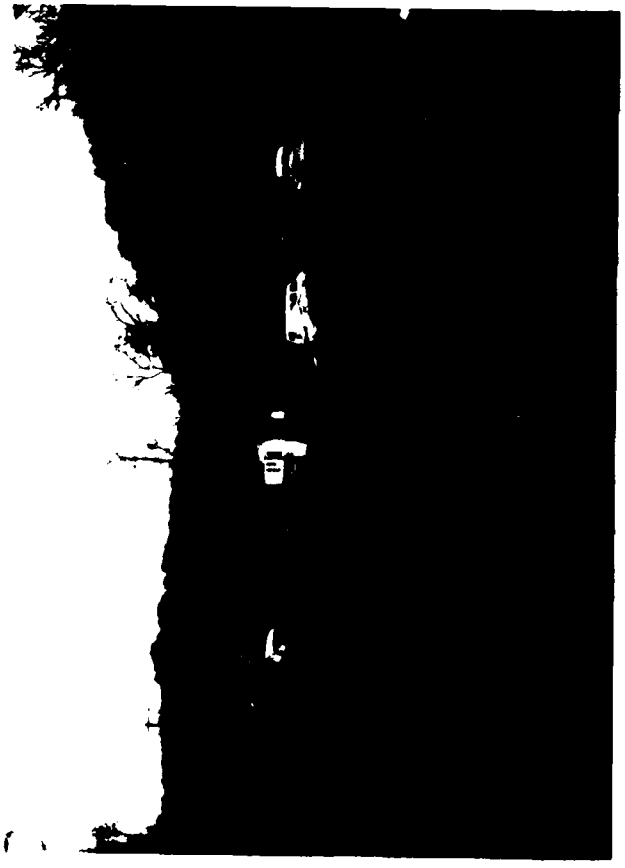
TOP OF PAGE

1,5	2,6
3,7	4,8









APPENDIX D
HYDROLOGY AND HYDRAULICS

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology. The dam overtopping and breach analyses were accomplished using the systemized computer program HEC-1 (Dam Safety Investigation), September, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation. The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Report No. 33" prepared by the U.S. Weather Bureau.

The index rainfall may be reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters their definition and how they were obtained for these analysis.

Parameter	Definition	Where Obtained
Ct	Coefficient representing variations of watershed	From Corps of Engineers*
L	Length of main stream channel miles	From U.S.G.S. 7.5 minute topgraphic
Lca	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic
Cp	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

3. Routing. Reservoir routing is accomplished by using Modified Plus routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input, and the program will calculate an elevation discharge relationship.

Storage in the pool area is defined by an area - elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping. Using given percentages of the PMF, the computer program will calculate the percentage of the PMF, which can be controlled by the reservoir and spillway without the dam overtopping.

5. Dam Breach and Downstream Routing. The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre-failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.

HYDROLOGY AND HYDRAULICS ANALYSIS
DATA BASE

NAME OF DAM: Chambers Dam

PROBABLE MAXIMUM PRECIPITATION (PMP) = 24.25 inches

STATION	1
Station Description	Chambers Dam
Drainage Area (square miles)	1.49
Cumulative Drainage Area (square miles)	1.49
Adjustment of PMP for Drainage Area (%)(1)	(Zone 7)
6 hours	102
12 hours	12[illegible]
24 hours	13[illegible]
48 hours	14[illegible]
72 hours	N/A
Snyder Hydrograph Parameters	
Zone (2)	29
Cp (3)	.5[illegible]
Ct (3)	1.5[illegible]
L (miles) (4)	1.5[illegible]
Lca (miles) (4)	.5[illegible]
tp = Ct(LxLca) 0.3 hrs.	1.47
Spillway Data	
Crest Length (ft)	21.5
Freeboard (ft)	0.5
Discharge Coefficient	3.2
Exponent	1.5

(1) Hydrometeorological Report 33 (Figure 1), U.S. Weather Bureau and U.S. Army Corps of Engineers, 1956.
(2) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's coefficients (C_p and C_t).
(3) Snyder's Coefficients.
(4) L=Length of longest water course from outlet to basin divide. L_{ca}=Length of water course from outlet to point opposite the centroid of drainage area.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 1.49 sq.mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1102.0 [50 ac-ft]

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Not applicable

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1102.5 [low spot]

SPILLWAY CREST:

a. Elevation 1102.0
b. Type Semi-broad crest
c. Width Effective crest length 21.5 feet
d. Length 10 feet [approximate]
e. Location Spillover Right abutment
f. Number and Type of Gates None

OUTLET WORKS:

a. Type Culvert through embankment
b. Location Near mid-embankment
c. Entrance inverts Unknown
d. Exit inverts Approximately 1090.0
e. Emergency drawdown facilities Culvert through embankment

HYDROMETEOROLOGICAL GAUGES:

a. Type None
b. Location None
c. Records None

MAXIMUM NON-DAMAGING DISCHARGE: Unknown

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

NAME CHAMBERS DAM
NUMBER PA-1093
SHEET NO. 1 OF 4
BY DTM DATE 3/81

LOSS RATE AND BASE FLOW PARAMETERS

AS RECOMMENDED BY THE BALTIMORE DISTRICT CORPS OF ENGINEERS.

STRTL = 1 INCH
CNSTL = 0.05 IN/HR
STRTQ = 1.5 CFS/MI^2
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.0

ELEVATION-AREA-CAPACITY RELATIONSHIPS

FROM U.S.G.S. 7.5-MIN. QUAD., DER FILES AND FIELD INSPECTION DATA.

SPILLWAY CREST ELEV. (U.S.G.S.) = 1102.0
NORMAL POOL AREA = 9.2 ACRES
INITIAL STORAGE = 46± AC-FT USE 50 AC-FT

FROM THE CONIC METHOD FOR RESERVOIR ROUTE. FLOOD HYDROGRAPH PACKAGE (HEC-1), DAM SAFETY VERSION (USERS MANUAL).

$H = 3V/A$
$= 3(50)/9.2$
$= 16.3'$

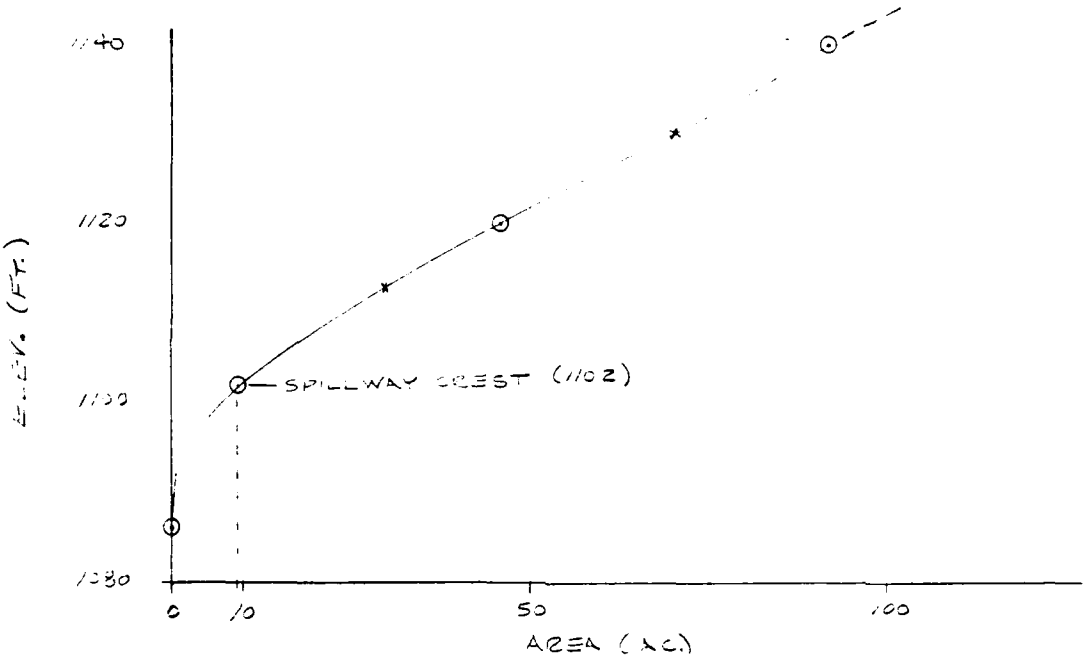
∴ ELEVATION WHERE AREA EQUALS ZERO;

$1102.0 - 16.3 = 1085.70$

FROM U.S.G.S.

AT ELEV. 1120, AREA = 46 ACRES
AT ELEV. 1140, AREA = 72 ACRES

TOP OF DAM LOW SPOT ELEVATION = 1102.5

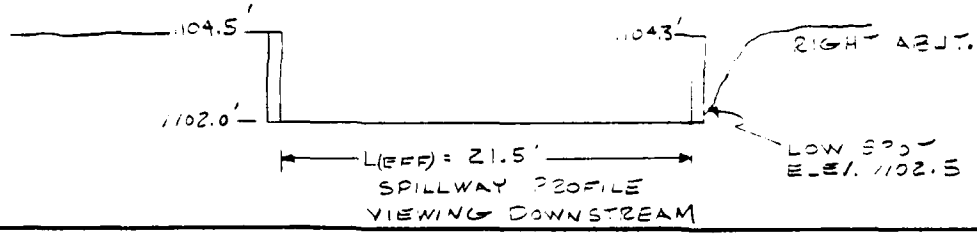


AREA (AC.)	0	9.2	30	46	70	92
ELEV. (FT.)	1085.7	1102	1113	1120	1130	1140

DISCHARGE RATING

$Q = C L H^{3/2}$ USE $C = 3.2$ (SEMI-BROAD CREST) } SPILLWAY
$L_{EFFECTIVE} = 23.0 - 1.5 = 21.5'$ }

$Q_{OVERTOPPING} = C L H^{3/2}$ USE $C = 3.0$
L VARIES WITH H



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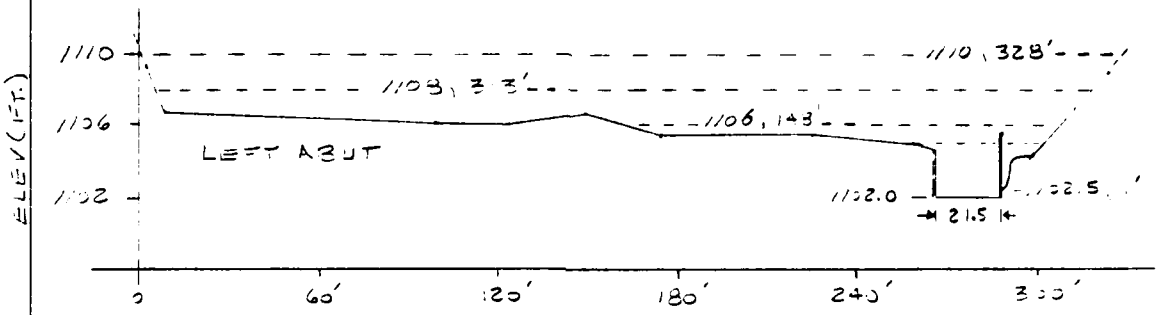
NAME
NUMBER PA-1093
SHEET NO. 3 OF 4
BY OTM DATE 3/81

NOTE: OVERTOPPING WILL BEGIN AT THE RIGHT ABUTMENT ADJACENT TO THE RIGHT SPILLWAY WINGWALL AFTER A VERY SHORT PERIOD OF TIME INTO THE STORM.

RATING CURVE INCLUDES OVERTOPPING.



ELEV. (FT.)	SPILLWAY h (FT.)	SPILLWAY L (FT.)	SPILLWAY Q (CFS)	OVERTOPPING h (FT.)	OVERTOPPING L (FT.)	OVERTOPPING Q (CFS)	DISCHARGE *Q (CFS)
1102	0	21.5	0				0
1102.5	0.5	"	25				25
1103	1	"	70	0.5	1'	5	70
1104.5	2.5	"	270	2	10'	85	355
1105				2.5	40'	475	745
1106				3.5	148'	2,905	3,175
1107				4.5	305'	8,735	9,005
1108				5.5	313'	12,110	12,380
1109				6.5	320'	15,910	16,130
1110				7.5	328'	20,210	20,430

* Q ROUNDED TO NEAREST 5 CFS.

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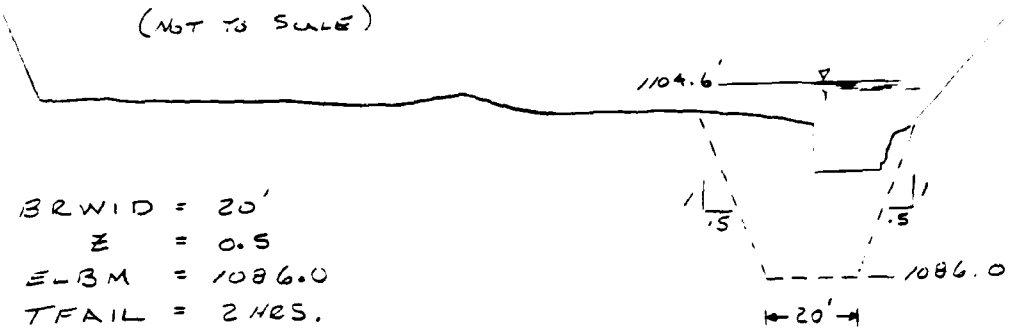
EBENSBURG PENNSYLVANIA

NAME
NUMBER PA-1093
SHEET NO. 4 OF 4
BY OTM DATE 3/81

FROM FIG. PAGE 3 OF 4

(NOT TO SCALE)



BRWID = 20'
Z = 0.5
E-BM = 1086.0
TFAIL = 2 HRS.
WSEL = 1102.0
FAILEL = 1104.6

0.1 PMF UTILIZED FOR BREACH ANALYSIS.

EACH CROSS-SECTION FROM U.S.G.S. 7.5-MIN. QUAD.

OVERBANK MANNINGS' n = 0.06 (ASSUMED)
CHANNEL MANNINGS' n = 0.05 (ASSUMED).

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************
    1              A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF THE PMF
    2              A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF CHAMBERS DAM
    3              A3       RATIOS OF PMF ROUTED THROUGH THE RESERVOIR (PA-1093)
    4              B    288       0      10       0       0       0       0       0       0       0
    5              B1     5
    6              J      1       4       1
    7              J1   .01      .1      .5       1
    8              K      0       1                                       1
    9              K1       INFLOW
   10              M      1       1    1.49                       1                               1
   11              P             24.25     102     120     130     140
   12              T                                                       1.0    0.05
   13              W    1.47 ,  0.50
   14              X    -1.5    -.05     2.0
   15              K      1       2                                       1
   16              K1       ROUTE THROUGH CHAMBERS
   17              Y                                       1       1
   18              Y1     1                                                -1102     -1
   19              Y4  1102  1102.5    1103  1104.5    1105    1106    1107    1108    1109    1110
   20              Y5     0      25      70     355     745    3175    9005   12980   16180   20480
   21              $A     0     9.2      30      46      70      92
   22              $E1085.7    1102    1113    1120    1130    1140
   23              $$  1102
   24              $D1102.5
   25              K     99
```

NPLAN= 1 NRTIO= 4 LRTIO= 1

RTIOS= .01 .10 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	TAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.49	0.00	1.49	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.25	102.00	120.00	130.00	140.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.47 CP= .50 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 9.42 AND R=12.05 INTERVALS

UNIT HYDROGRAPH 69 END-OF-PERIOD ORDINATES, LAG= 1.48 HOURS, CP= .50 VOL= 1.00

11.	42.	86.	137.	193.	246.	289.	318.	332.	325.
302.	278.	256.	235.	217.	199.	183.	169.	155.	143.
132.	121.	111.	103.	94.	87.	80.	74.	68.	62.
57.	53.	49.	45.	41.	38.	35.	32.	30.	27.
25.	23.	21.	19.	18.	16.	15.	14.	13.	12.
11.	10.	9.	8.	8.	7.	7.	6.	6.	5.
5.	4.	4.	4.	3.	3.	3.	3.	2.	

HYDROGRAPH ROUTING

ROUTE THROUGH CHAMBERS

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1102.	-1

STAGE	1102.00	1102.50	1103.00	1104.50	1105.00	1106.00	1107.00	1108.00	1109.00	1110.00
FLOW	0.00	25.00	70.00	355.00	745.00	3175.00	9005.00	12380.00	16180.00	20480.00
SURFACE AREA=	0.	9.	30.	46.	70.	92.				
CAPACITY=	0.	50.	255.	519.	1094.	1902.				
ELEVATION=	1086.	1102.	1113.	1120.	1130.	1140.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1102.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1102.5	0.0	0.0	0.

STATION 2. PLAN 1. RATIO 1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .01	RATIO 2 .10	RATIO 3 .50	RATIO 4 1.00
HYDROGRAPH AT	1	1.49	1	48.	480.	2398.	4796.
	(	3.86)	(	1.36)(	13.58)(	67.90)(	135.80)(
ROUTED TO	2	1.49	1	37.	464.	2395.	4791.
	(	3.86)	(	1.04)(	13.14)(	67.82)(	135.65)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1102.00	1102.00	1102.50
STORAGE	50.	50.	55.
OUTFLOW	0.	0.	25.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.01	1102.63	.13	56.	37.	3.67	42.67	0.00
.10	1104.64	2.14	79.	464.	15.00	41.33	0.00
.50	1105.68	3.18	94.	2395.	27.50	41.17	0.00
1.00	1106.28	3.78	103.	4791.	31.83	41.17	0.00

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                 A1       RATIOS OF PMF ROUTED THROUGH THE RESERVOIR AND DOWNSTREAM
    2                 A2       DOWNSTREAM CONDITION DUE TO OVERTOPPING OF CHAMBERS DAM
    3                 A3       PLAN 1 ASSUMES BREACH. PLAN 2 ASSUMES NO BREACH (PA-1093)
    4                 B    288        0       10        0        0        0        0        0        0        0
    5                 B1     5
    6                 J      2        1        1
    7                 J1    .1
    8                 K      0        1                                          1
    9                 K1       INFLOW
   10                 M      1        1    1.49                                  1                 1
   11                 P            24.25      102      120      130      140
   12                 T                                                      1.0     0.05
   13                 W   1.47     0.50
   14                 X   -1.5     -.05      2.0
   15                 K      1        2                                          1
   16                 K1       ROUTE THROUGH CHAMBERS
   17                 Y                                  1        1
   18                 Y1     1                                                -1102       -1
   19                 Y4  1102   1102.5     1103   1104.5     1105     1106     1107     1108     1109     1110
   20                 Y5     0       25       70      355      745     3175     9005    12380    16180    20480
   21                 $A     0      9.2       30       46       70       92
   22                 $E1085.7     1102     1113     1120     1130     1140
   23                 $$  1102
   24                 $D1102.5
   25                 $B    20       .5     1086        2     1102   1104.6
   26                 $B    20       .5     1086        2     1102     1107
   27                 K      1        3                                          1
   28                 K1       REACH NO. 1
   29                 Y                                  1        1
   30                 Y1     1
   31                 Y6   .06      .05      .06     1033     1060     6000     0.01
   32                 Y7     0     1060      100     1040      110     1035      112     1033      118     1033
   33                 Y7   120     1035      300     1040      500     1060
   34                 K     99
```

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 01 APR 80
****

RUN DATE= 81/03/09.
TIME= 12.17.53.

RATIOS OF PMF ROUTED THROUGH THE RESERVOIR AND DOWNSTREAM
DOWNSTREAM CONDITION DUE TO OVERTOPPING OF CHAMBERS DAM
PLAN 1 ASSUMES BREACH, PLAN 2 ASSUMES NO BREACH (PA-1093)

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	10	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 2 NRTIO= 1 LRTIO= 1

RTIOS= .10

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.49	0.00	1.49	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.25	102.00	120.00	130.00	140.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.47 CP= .50 RIA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 9.42 AND R=12.05 INTERVALS

UNIT HYDROGRAPH 69 END-OF-PERIOD ORDINATES, LAG= 1.48 HOURS, CP= .50 VOL= 1.00

11.	42.	86.	137.	173.	246.	289.	318.	332.	325.
302.	278.	256.	235.	217.	199.	183.	169.	155.	143.
132.	121.	111.	103.	94.	87.	80.	74.	68.	62.

HYDROGRAPH ROUTING

REACH NO. 1

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0500	.0600	1033.0	1060.0	6000.	.01000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1060.00 100.00 1040.00 110.00 1035.00 112.00 1033.00 118.00 1033.00
120.00 1035.00 300.00 1040.00 500.00 1060.00

STORAGE	0.00	1.45	5.22	18.73	42.80	77.43	118.97	164.69	214.57
//1268.63									
	326.87	389.27	455.85	526.59	601.52	680.61	763.87	851.31	942.92
//1038.71									
OUTFLOW	0.00	32.52	137.87	517.27	1389.85	2948.10	5519.02	8860.49	12974.72
.17877.77									
	23592.08	30143.53	37559.92	45870.17	55103.83	65290.75	76460.91	88644.25	101870.65
116169.79									
STAGE	1033.00	1034.42	1035.84	1037.26	1038.68	1040.11	1041.53	1042.95	1044.37
//1045.79									
	1047.21	1048.63	1050.05	1051.47	1052.89	1054.32	1055.74	1057.16	1058.58
//1060.00									
FLOW	0.00	32.52	137.87	517.27	1389.85	2948.10	5519.02	8860.49	12974.72
117877.77									
	23592.08	30143.53	37559.92	45870.17	55103.83	65290.75	76460.91	88644.25	101870.65
116169.79									

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 .10
				RATIOS APPLIED TO FLOWS
HYDROGRAPH AT	1	1.49	1	480.
	(	3.861)	(	13.581)
			2	480.
			(	13.581)
ROUTED TO	2	1.49	1	1315.
	(	3.861)	(	37.251)
			2	464.
			(	13.141)
ROUTED TO	3	1.49	1	1163.
	(	3.861)	(	32.951)
			2	438.
			(	12.391)

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1102.00	1102.00	1102.50
STORAGE	50.	50.	55.
OUTFLOW	0.	0.	25.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1104.63	2.13	79.	1317.	9.21	42.54	41.17

PLAN 2 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1102.00	1102.00	1102.50
STORAGE	50.	50.	55.
OUTFLOW	0.	0.	25.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1104.64	2.14	79.	464.	15.00	41.33	0.00

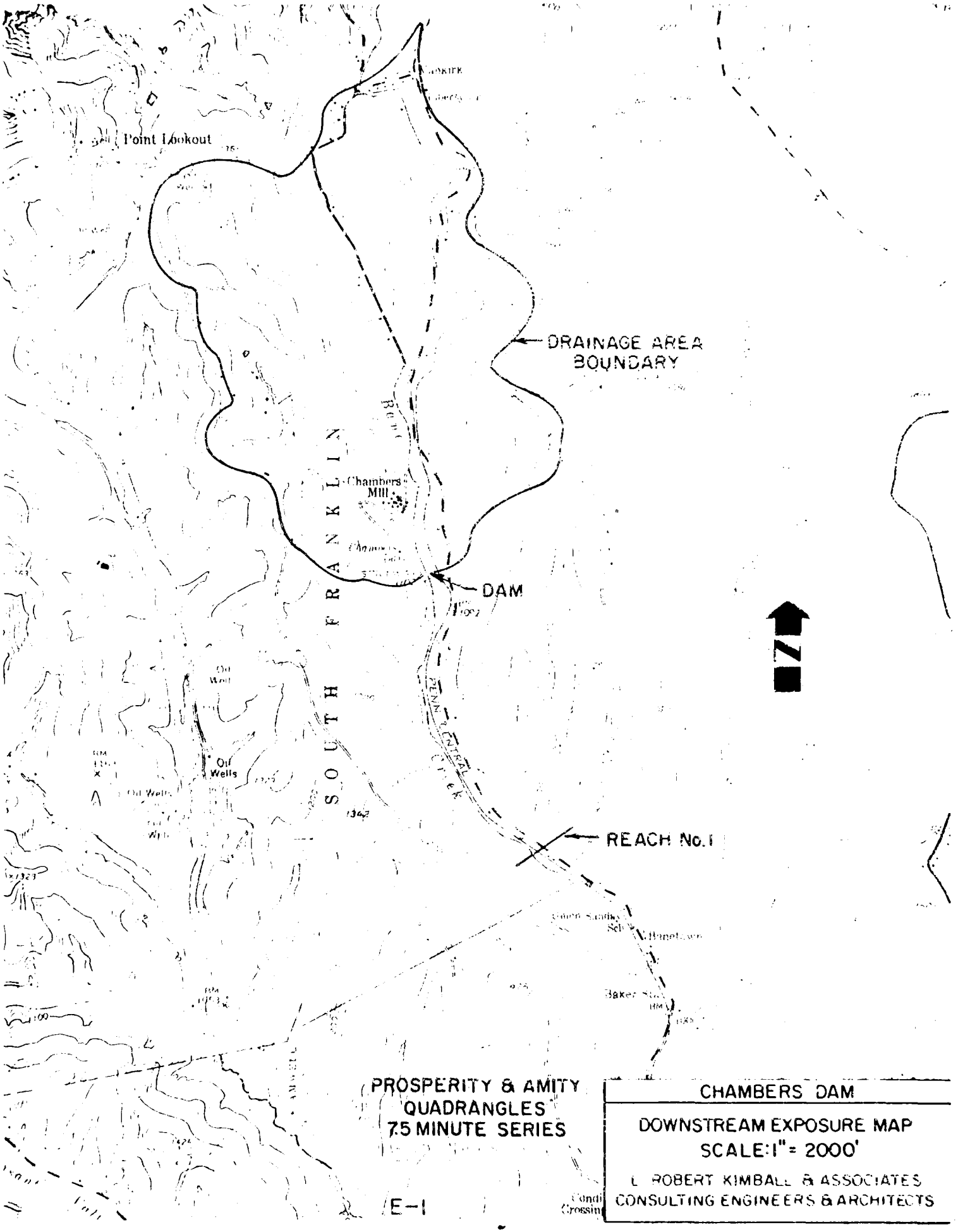
PLAN 1 STATION 3

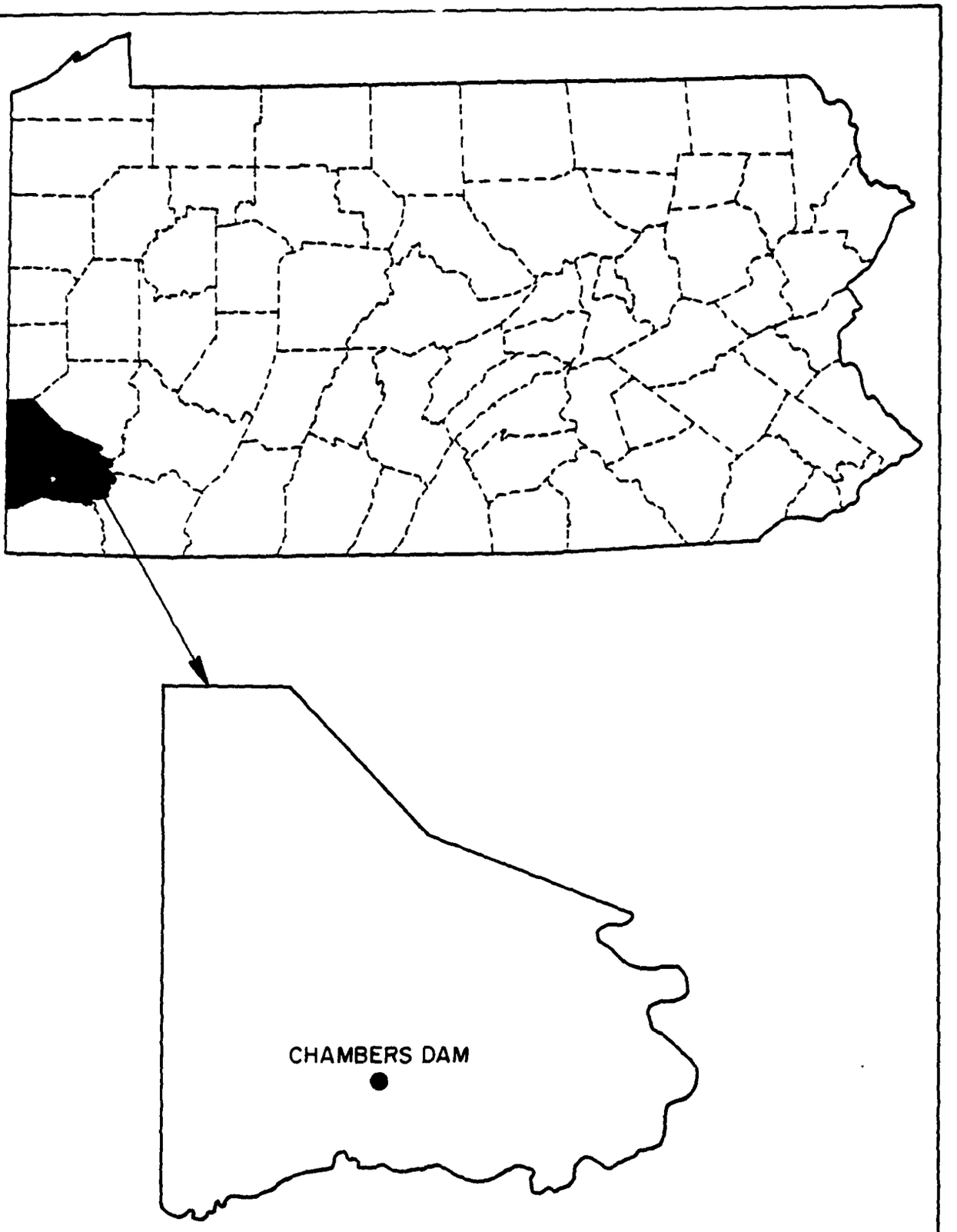
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	1163.	1038.3	42.67

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	438.	1037.0	42.00

APPENDIX E
DRAWINGS


Point Lookout
DRAINAGE AREA BOUNDARY
Chambers Mill
DAM
SOUTH FRANKLIN
Oil Wells
REACH No.1
PROSPERITY & AMITY QUADRANGLES 7.5 MINUTE SERIES
CHAMBERS DAM
DOWNSTREAM EXPOSURE MAP
SCALE: 1" = 2000'
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS



SITE LOCATION MAP
WASHINGTON COUNTY, PENNSYLVANIA

APPENDIX F
GEOLOGY

General Geology

The Chambers Dam is located in the Pittsburgh Plateaus Section of the Appalachian Plateaus Province. This section typically consists of rounded hills and ridges, products of a dissected plateau. In the study area, the ridges become more definite and the folds become broader. In this region the sediments are deformed by several sub-parallel secondary folds which are superimposed upon a major spoon-shaped trough of first magnitude in the southwestern Pennsylvania and adjacent regions. The axes of these folds trend about N30-50° E, plunging gently southward. Chambers Dam lies just east of the Ninevah Synclinal axis (N52E); to the northwest is the Washington Anticline and to the southast is the Amity Anticline. The strata in the vicinity of the dam strike northeast and dip less than 2° to the northwest. No major faulting is noted in the area.

The bedrock underlying the dam consists of thin-bedded shaly sandstone with thin shaly limestone beds belonging to the Fish Creek Sandstone of the Greene Formation, a member of the Dunkard Group of Lower Permian Age. The detrital sediments of the Greene epoch grade laterally from one type to another, with an increase of silt in the later part of the epoch. The strata of the Greene Formation are extremely variable in lithology and thickness and are not a highly productive source of groundwater.

The Chambers Dam is located in the Main Bituminous Coal Field. The Pittsburgh Coal seam lies about 700 feet below the dam and has not been mined out as of 1964. The possibility of future mining of this seam and other coal seams exists.

GEOLOGIC MAP OF THE AREA AROUND CHAMBERS DAM, COKEBURG WATER SUPPLY DAM AND BENTLEYVILLE DAM

SCALE: 1:250,000

PERMIAN

Greene Formation

Cyclic sequences of sandstone, shale, red beds, limestone, and coal, base at the top of the Upper Washington Limestone

PERMIAN AND PENNSYLVANIAN

PPw

Washington Formation

Cyclic sequences of sandstone, shale, lime stone and coal, some red shale, some mine able coal, base at the top of the Waynesburg Coal

PENNSYLVANIAN

APPALACHIAN PLATEAU

Pm

Monongahela Formation

Cyclic sequences of sandstone, shale, lime stone and coal, limestone prominent in northern outcrop areas, shale and sand stone increase southward, commercial coals present, base at the bottom of the Pittsburgh Coal


LME